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EVALUATION OF WORK-RELATED NEUROMUSCULAR FATIGUE AND DISCOMFORT IN FEMALE SALES WORKERS

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The aim of this study was to compare neuromuscular fatigue and discomfort following workday in groups of sales workers, who were working predominantly in standing or sitting position. Ten female sales workers (aged 21–66 yrs), who worked predominantly in standing position (ST) and 9 female sales workers (aged 20–54 yrs), who worked predominantly in sitting position (SI) participated in this study. Neuromuscular fatigue and discomfort after the workday immediately was subjectively evaluated by 10-point visual analogue scale (VAS) in neck, shoulder, low-back and leg regions. Visual-motor coordination was assessed by Grooved Pegboard test and hand grip strength for both arms was tested by hand dynamometer before and after the workday. The results indicated that after the workday, subjectively evaluated neuromuscular fatigue and discomfort in ST group was higher ($p<0.05$) in posterior calf region compared with SI group. SI group felt subjectively significantly higher ($p<0.05$) neuromuscular fatigue and discomfort in shoulder region after the workday as compared to ST group. Before the workday, the Grooved Pegboard test time was shorter ($p<0.05$) in SI group, whereas hand grip strength for right arm was higher ($p<0.05$) in ST group. No significant work-related changes were found in Grooved Pegboard test time and hand grip strength in the measured groups. It was concluded that following the workday, subjectively evaluated neuromuscular fatigue and dis-

comfort was more pronounced in ST group in posterior calf region and in SI group in shoulder muscles. No significant fatigue-induced changes in visual-motor coordination and in voluntary isometric force-generation capacity of hand muscles were established in female sales workers following the workday.

Key words: neuromuscular fatigue, visual-motor coordination, muscle force, sales workers

INTRODUCTION

Musculoskeletal disorders (MSD) are a major cause of work-related disability [9]. It has been suggested that working long time in standing or sitting position causes MSD [10]. Sales workers, who have to stand or sit throughout the workday, are affected by diseases like varicose veins, poor feet blood supply, swelling, heart and circulation problems. Salespersons working predominantly in sitting position (SI) are in forced position and therefore their neck and back muscles are overloaded. Muscles blood supply and oxygen accessibility causes fatigue and pain in muscles. According to Lehman et al [8], sales workers health problems were associated with the low back (32%), wrist (28%), neck (21%) and shoulder (21%). Long-time standing is often associated with musculoskeletal problems, in including discomfort, fatigue and pain affecting the lower limbs, and low back, often in the whole body. People who have to stand up for a long time can suffer more serious health problems such as lower limb swelling and blood flow restriction [3]. Working in sitting position consumes less muscle force, but this body posture causes low back pain, muscle tension, and muscle pain. People who work in sitting position have to consider that their health can deteriorate when they do not exercise or are not otherwise physically active. Lack of movement can cause hypokinesia. Reduced blood flow to muscles can cause fatigue, therefore employees working in sitting position, who do not do physically hard work, feel highly fatigued at the end of workday. Constant sitting affects mostly the neck and lower back region [2].

The aim of this study was to assess neuromuscular fatigue and discomfort in sales workers working in standing or sitting position before and after the workday. The measurements were carried out at the workplace.

METHODS

Subjects

Ten female sales workers, who were working predominantly in standing position (aged 21–66 yrs) (ST) and nine female sales workers, who were working predominantly in sitting position (aged 20–54 yrs) (SI) participated in this study. The anthropometric parameters of the subjects are presented in Table 1. The ST group worked in clothes shop, selling merchandise over the counter, the SI group worked as cashiers in grocery store.

Table 1. Anthropometric parameters of the subject groups (mean ± SE)

Variable	ST group n=10	SI group n=9
Age (yrs)	36.3±4.3	37.6±4.4
Height (cm)	167.9±2.3	169.3±2.7
Body mass (kg)	62.2±2.9***	78.1±8.6
Body mass index ($kg \cdot m^2$)	22.2±1.3	26.9±2.4
Length of employment (yrs)	6.6±1.4	1.8±0,5
General length of employment (yrs)	16.9±4.3	18.2±4.5
Working time per week (hours)	40.0±0.8	41.1±0.7

ST – sales workers, who were working predominantly in standing position, SI – sales workers, who were working predominantly in sitting position. *** $p<0.001$. Significantly different compared with sales workers, who were working predominantly in sitting position.

Data collection

The measurements were carried out immediately at the end of the workday. The height and body mass of the subjects were measured with metal anthropometer, and electronic scales, respectively and the body mass index (kg/m^2) of the subjects was calculated. In the course of the research, the subjects completed a questionnaire. Neuromuscular fatigue and discomfort were subjectively evaluated in neck,

shoulder, and leg regions by visual analogue scale (VAS; Figure 1) [5, 6]. VAS included numbers from 0 to 10. Perceived exertion was estimated in the following way: 0 – not fatigued, 10 – completely fatigued. To evaluate visual-motor coordination was used the Grooved Pegboard test (Model 32025). The Grooved Pegboard test is a manipulative dexterity test consisting of 25 holes with randomly positioned slots. Pegs with a key along one side must be rotated to match the hole before they can be inserted. The duration of the test was recorded. The test was performed in sitting position by using the dominant hand. Hand grip strength was measured with hand dynamometer (Lafayette Dynamometer Model 78011, USA). The handle of the dynamometer was adapted at 1.5 cm distance. The subject pressed dynamometer in standing position, keeping the hands away from the body. Hand grip strength of both extremities was measured, whereas 3 trials were conducted and the best result was taken for further analyses. The results were presented in Newtons (N).

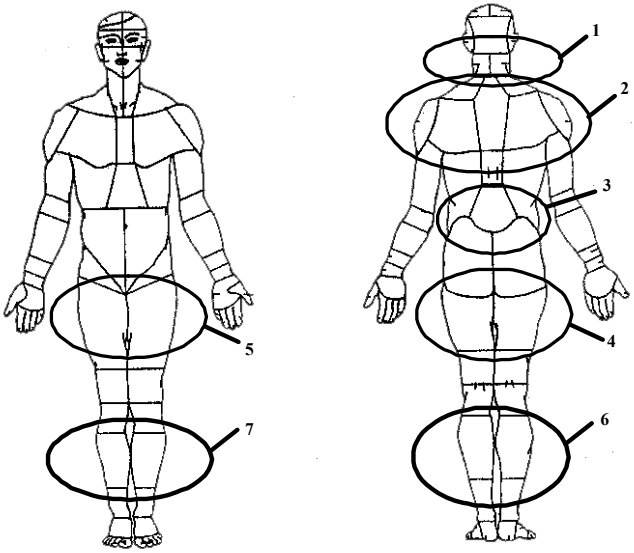

Figure 1. Schematic presentation of subjective evaluation of neuromuscular fatigue and discomfort by visual analogue scale (VAS) from different body regions. 1 – neck, 2 – shoulder, 3 – low-back, 4 – posterior part of thigh, 5– anterior part of thigh, 6 – posterior part of calf, 7 – anterior part of calf.

Statistical analysis

Means and standard errors (±SE) of mean were calculated. The differences of the means of the groups, as well as the significance of the changes for the groups of subjects at the beginning of the workday and after it, were evaluated on the basis of the Mann–Whitney U-test. Comparisons were performed two-tailed and differences were considered significant at $p<0.05$.

RESULTS

According to VAS, SI group felt subjectively significantly higher ($p<0.05$) neuromuscular fatigue and discomfort in shoulder region after the workday as compared to ST group (Figure 2A). After the workday, subjectively evaluated neuromuscular fatigue and discomfort in ST group was higher ($p<0.05$) in posterior calf region compared with ST group (Figure 2B). No significant differences ($p>0.05$) in subjectively evaluated neuromuscular fatigue and discomfort were found in neck, low back, thigh and anterior region of calf in the measured groups of female sales workers. After the workday, the Grooved Pegboard test time in ST group was shorter ($p<0.05$) as compared to the pre-workday level (Figure 3). No significant differences ($p>0.05$) between the measured groups in this parameter were found before and after the workday. Before the workday, hand grip strength for the right arm was higher ($p<0.05$) in ST group compared to SI group (Figure 4), whereas no significant between-group differences were established after the workday. No significant work-related changes following the workday were found in the Grooved Pegboard test time and hand grip strength in the measured groups.

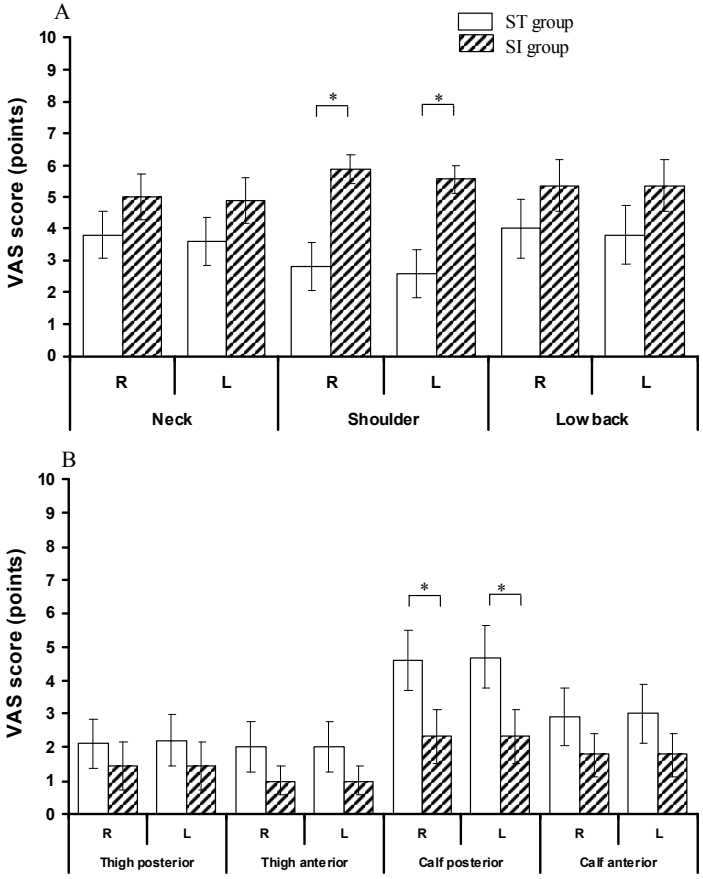

Figure 2. Subjectively evaluated neuromuscular fatigue and discomfort by visual analogue scale (VAS) from different body regions in sales workers, who were working predominantly in standing (ST) or sitting (SI) position (mean±SE). *$p<0.05$.

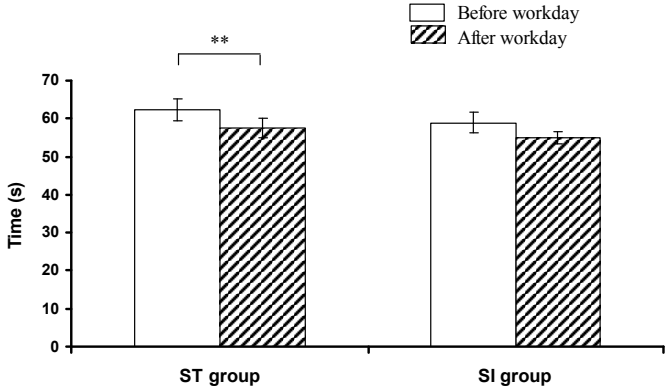

Figure 3. Visual-motor coordination time measured by Grooved Pegboard test in sales workers, who were working predominantly in standing (ST) or sitting (SI) position (mean±SE). **p<0.01.

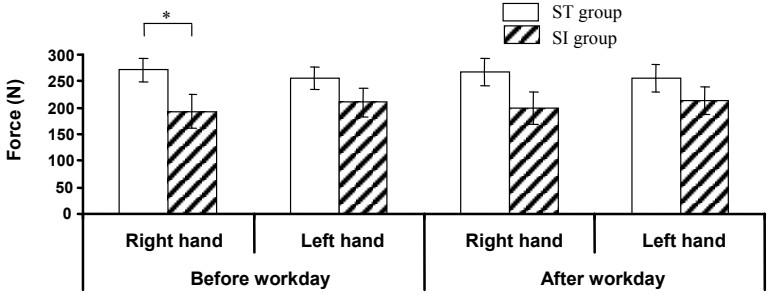

Figure 4. Hand grip strength in sales workers, who were working predominantly in standing (ST) or sitting (SI) position (mean±SE). *p<0.05.

DISCUSSION

Significant discomfort and fatigue of shoulder region (p<0.05) in SI group compared to ST group was observed in this study. In ST group of the subjectively evaluated neuromuscular fatigue and discomfort by VAS in shoulder region was on an average by 47% lower than in SI group. This is agreement with the results of several previous studies [7, 8, 11], indicating a significant reduction of discomfort in the muscles of upper extremities in sales workers, who had to stand

throughout the workday. Significant discomfort and fatigue was established in calf posterior muscles in ST group compared to SI group. In the present study subjectively evaluated neuromuscular fatigue and discomfort by VAS in calf region of ST group were by 50% higher than in SI group. In standing position the lower extremities are more loaded than in sitting position, where the most loaded body regions are in shoulders and neck. Physical work requirements and individual factors determine muscle force and length characteristics as a function of time, which in turn determines muscle energy requirements. Muscle energy requirements can lead to fatigue, which can further lead to muscle disorders [8]. This may explain why employees who have to sit throughout the workday (e.g. office workers, cashiers) often experience MSD symptoms in shoulder region and neck [4, 8, 12]. At the end of the workday, no significant differences between ST and SI group were observed in neuromuscular fatigue and discomfort evaluated by VAS in neck, low back, anterior and posterior thigh, and anterior calf in this study. These results are directly related with working position and hypokinesia, which impairs motor ability [1].

In the present study visual-motor coordination time in ST and SI groups was measured. It was found that the visual-motor coordination time was significantly shorter after the workday was as compared to before workday in ST group. Thus, visual-motor coordination was improved following the workday in both groups. At the end of the workday the subjects performed better the visual-motor coordination test, because the test was made for the second time and participants were familiar with its content.

Before the workday, hand grip strength for the right arm was higher on an average by 29% ($p<0.05$) in ST group compared to SI group, whereas no significant between-group differences were established after the workday. The hand grip strength was stabilized in female sales workers, and arms were not fatigued.

Working in standing position increases neuromuscular fatigue and discomfort in calf muscles. It has been suggested that long-term standing on a hard floor causes fatigue and discomfort compared to a softer floor [3]. Regular resting in sitting position reduces fatigue in calf muscles. Relaxing and stretching exercises reduce static tension and discomfort in shoulder region and neck.

Weakness of the present study was a relatively sample size. More research is needed to objectively evaluate fatigue and discomfort,

which relates to standing and sitting work position, using myotonometry and electromyography.

It was concluded that following the workday, subjectively evaluated neuromuscular fatigue and discomfort was more pronounced in ST group in posterior calf region and in SI group in shoulder muscles. In ST group visual-motor coordination was improved following the workday. No significant fatigue-induced changes in voluntary isometric force-generation capacity of hand muscles were established in female sales workers following the workday.

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